Response to the Government Issues Paper

on

A Sustainable Population Strategy for Australia

A submission by the

Australian Academy of Technological Sciences and Engineering

(ATSE)

March 2011

Australian Academy of Technological Sciences and Engineering

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4th March 2011

The Australian Academy of Technological Sciences and Engineering (ATSE) welcomes the opportunity to respond to the Government issues paper on *A Sustainable Population Strategy for Australia*.

Executive Summary

The Australian Academy of Technological Sciences and Engineering (ATSE) supports the proposal to formulate a Sustainable Population Strategy. ATSE is pleased to contribute to this submission and seeks to highlight the findings of a number of our policy reports which are relevant to the issues paper. ATSE has a strong track record of active engagement in this area and would be pleased to continue to provide advice to the government on an ongoing basis as it proceeds with the formulation of the Sustainable Population Strategy.

ATSE broadly agrees with the considerations identified in the issues paper. This submission addresses various challenges to a sustainable Australian population: water, energy, climate change, infrastructure, education and health technology and draws on the findings of numerous ATSE reports, including: *30/50* (2007)[1], which concluded that there were no insurmountable engineering, scientific or environmental barriers to reaching a sustainable Australian population of 30 million by 2050, provided that an appropriate policy framework is developed; *Smart Technology for Healthy Longevity* (2010)[2]*; Low Carbon Energy* (2010)[3]; and *Climate Change and the Urban Environment* (2009)[4].

Introduction

ATSE is an independent, non-government organisation with a mission to "foster excellence in technological sciences and engineering to enhance Australia's competitiveness, economic and social wellbeing and environmental sustainability". ATSE provides independent, evidence-based, robust policy advice in the broad areas of applied science and technology. To deliver this, ATSE draws on the expertise of our Fellowship of over 800 eminent scientists and engineers (who are elected to the Fellowship). ATSE works to improve participation and literacy rates in science and mathematics subjects in Australian schools, through the STELR[i] program[5]. Furthermore, the ATSE Clunies Ross Award[6] recognises the application of science and technology for the economic, social or environmental benefit of Australia.

ATSE holds a strong record of undertaking work and delivering policy advice in numerous areas relevant to sustainable population (including energy, water, climate change, health technology and infrastructure); some examples of this are referred to in the 'Key Issues' section below. A current initiative of particular relevance to the Sustainable Population Strategy is the ATSE *Green Growth* project[7]. This project seeks to explore the mechanisms through which an economy can be expanded in a sustainable way.

ATSE would be pleased to provide advice to the Australian Government to further the formulation of the Sustainable Population Strategy (henceforth referred to as 'the Strategy') on an ongoing basis.

Key issues

- **Australia 30/50[1]: barriers to a sustainable Australian population of 30million by 2050**

  The 2007 ATSE report *30/50: The Technological Implications of an Australian Population of 30 million by 2050*[1] explored the engineering, scientific and environmental barriers to reaching an Australian population of 30 million by 2050. The study considered three systemic issues which are common to all resource and infrastructure issues (climate change, infrastructure investment and planning issues) and five topics in detail (water, energy, transport, waste management and social infrastructure). The ATSE study found:

  - There are no inherent physical, resource or technological barriers to achieving an Australian population of 30 million by 2050;
  - Thorough analysis and long term planning is imperative to ensure timely and orderly provision of needed infrastructure; and
  - Leadership from governments is essential in setting clear policy directions.

  For further information, the report overview is enclosed in this submission (Appendix 1).

[i] Science and Technology Education Leveraging Relevance

- **Economic challenges of an ageing population: ageing-in-place**
  ATSE notes that the issues paper identifies population growth and demographic ageing as key considerations for a sustainable Australia and agrees that there is a need to plan for this population change to ensure future economic health, prosperity and sustainability for Australia.
  ATSE recommends that an increased national focus on the R&D, demonstration, commercialisation and wide-scale deployment of smart enabling technologies is required to enable older Australians to remain in their homes for longer, provide cost effective solutions to meet the needs of an ageing population and address the projected shortfall in the number of healthcare professionals. A new funding model is required for the wide-scale deployment of technology for the ageing population.
  ATSE is actively engaged in the area of 'Health and Technology' and is pleased to provide the Strategy with advice in this area. The 2010 ATSE report *Smart Technology for Healthy Longevity*[2] provides a 'blue-print' for further research and action. For further information, the short guide to the 2010 ATSE report is enclosed in this submission (Appendix 2).

- **Economic challenges of energy**
  ATSE recommends that detailed economic modelling be undertaken in order to determine the total cost implications of low-carbon energy. ATSE has undertaken work in this area through the landmark 2010 ATSE report *Low Carbon Energy: Evaluation of new energy technology choices for electric power generation in Australia*[3], a major conclusion of which is that there will be a need for massive investments to be made in generating capacity over the next 40 years to satisfy growth and emissions targets and to replace old facilities. The uncertainty over carbon pricing has meant there will be a reluctance to commit to the required investment, so in any scenario which envisages high levels of population growth energy security could emerge as a major restraint. ATSE believes that, amongst the many scenarios, nuclear energy should be considered. There is a limit to the amount of intermittent renewable energy able to be absorbed by the national grid and technical and cost uncertainties could well mean that the confidence currently in new carbon capture and geothermal technologies to help meet future demand could well be misplaced. For further information, the short guide to the report is enclosed in this submission (Appendix 3). The recommendations from this report are in line with those of the 2008 ATSE report *Energy Technology for Climate Change: Accelerating the Technology Response*[8].

  The 2009 ATSE report *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*[9] identified a clear need for a portfolio of energy options to meet the demands of a growing population, in an economic fashion. A greater focus on quantifying externalities (environmental and social costs that are not accounted for in the market price of electricity) is required to enable Australia to gain maximum social and environmental benefit from the portfolio of electricity generating technologies.

- **Skills and Education**
  ATSE agrees that a key challenge in working towards a sustainable Australia is ensuring that the Australian labour market has access to the skills and labour that it needs. ATSE sees the education of students in science, technology, engineering and mathematics as a key enabler to secure the future skills base. ATSE is actively engaged in promoting such education in Australian schools through the STELR[5] project (Science and Technology Education Leveraging Relevance), which involves over 24,000 Year 9 and 10 students and 750 teachers in 185 schools nationwide. The primary aim of the project is to address the problem of low participation rates in science and mathematics subjects in Australian upper secondary schools by relating these subjects to highly relevant issues affecting all students. The 2011 theme of this initiative is renewable energy, to address the concerns of students regarding climate change and to provide a resource to enhance the teaching of science fundamentals. ATSE is also a partner of the ANET (Australian National Engineering Taskforce)[10] program, addressing the critical shortage of engineers in Australia.

- **Productivity**
  ATSE recognises the fundamental importance of increasing the productivity of Australia's workforce to maintain economic growth. The Academy sees innovation as a key driver in achieving this, supported strongly by the technological sciences and engineering. ATSE is actively working in this area. Two examples of our current projects are a national symposium on the topic of 'prosperity and innovation', to held in November 2011, Melbourne and an international workshop on *strengthening collaborative links between industry and public research,* to be held in Sydney in May 2011.

- **Climate Change and Infrastructure**
  The 2009 ATSE report *Climate Change and the Urban Environment: Managing our urban areas in a changing climate*[11], considered, in the context of a changing climate, key issues associated with urban areas and planning, water management, building design, transport, and human health and wellbeing. The report concluded that climate change is a substantial addition to the numerous stresses already affecting the development of Australian cities and the well-being of citizens living in them; nationally consistent and multi-disciplinary mechanisms are needed to ensure that our cities remain resilient and sustainable under climate change. There are numerous examples within the report.
  The 2008 ATSE report *Assessment of impacts of climate change on Australia's physical infrastructure*[12] details a qualitative assessment of the risk of the impact of climate change on Australia's physical infrastructure, considering adaptations of existing infrastructure and requirements for future infrastructure. The report found that the impacts of current climate change projections have the potential to significantly challenge the capacity of elements of Australia's physical infrastructure and that action

needs to be taken at the national level to ensure that appropriate adaptation measures can be implemented to meet these challenges.

- **Water**
  In 2010, ATSE held an international workshop *Water and its Interdependencies on the Australian Economy*[13] which highlighted the complex interactions of water in the Australian economy.
  The 2007 ATSE report *Urban Water: Review of Water Supply Planning for Australia's Non-Metropolitan Urban Water Utilities*[14] explores the roles of planning and technology to address challenges of water supply in the context of a growing population. The report highlights the need for careful planning and investment in supporting co-ordinated programs on recycling, desalination, storage, water use and water management.

Conclusion

ATSE has a strong record of providing independent, evidence-based and robust policy advice, in numerous areas, including: energy, water, health, climate change impacts and infrastructure. In undertaking our policy work, the Academy draws on the expertise of our Fellowship, of over 800 eminent Australian scientists and engineers.

The Academy supports the development of *A Sustainable Population Strategy for Australia* and broadly agrees with the considerations identified in the issues paper. The Academy welcomes the opportunity to provide further input based on our extensive work in this area. The Academy is willing to deliver evidence-based policy advice to the government to aid the formulation of the Strategy, on an ongoing basis.

Further Information

All of the ATSE reports referred to here are freely available at the ATSE website www.atse.org.au .

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[1] Australian Academy of Technological Sciences and Engineering (2007) *30/50 The Technological Implications of an Australian Population of 30 Million by 2050* Report of a study for the Scanlon Foundation by the Academy of Technological Sciences and Engineering

[2] Australian Academy of Technological Sciences and Engineering (2010) *Smart Technology for Healthy Longevity*

[3] Australian Academy of Technological Sciences and Engineering (2010) *Low Carbon Energy: Evaluation of New Energy Technology Choices for Electric Power Generation in Australia*

[4] Australian Academy of Technological Sciences and Engineering (2009) *Climate Change and the Urban Environment: Managing our urban areas in a changing climate* Workshop Report, Melbourne Business School, 8th July - 10th July 2009

[5] Science and Technology Education Leveraging Relevance http://www.stelr.org.au/about-stelr/

[6] ATSE Clunies Ross Awards http://www.cluniesross.org.au/the-foundation

[7] Australian Academy of Technological Sciences and Engineering (2010) *Green Growth* Workshop, 27-29 April, Seoul, Korea *http://www.atse.org.au/atse-in-action/82/146-australia-korea-green-growth-intl-workshop-april-2010*

[8] Australian Academy of Technological Sciences and Engineering (2008) *Energy Technology for Climate Change: Accelerating the Technology Response*

[9] Australian Academy of Technological Sciences and Engineering (2009) *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*

[10] Australian National Engineering Taskforce http://www.anet.org.au/

[11] Australian Academy of Technological Sciences and Engineering (2009) *Climate Change and the Urban Environment: Managing our urban areas in a changing climate* Workshop Report, Melbourne Business School, 8th July - 10th July 2009

[12] Australian Academy of Technological Sciences and Engineering (2008) *Assessment of impacts of climate change on Australia's physical infrastructure*

[13] Australian Academy of Technological Sciences and Engineering (2010) *Water and its Interdependencies on the Australian Economy* Workshop 22-23June 2010, Sydney

[14] Australian Academy of Technological Sciences and Engineering (2007) *Urban Water: Review of Water Supply Planning for Australia's Non-Metropolitan Urban Water Utilities*

Appendix 1

30/50: Overview of a study for the Scanlon Foundation by the Australian Academy of Technological Sciences and Engineering[1] **(2007)**

[1] Australian Academy of Technological Sciences and Engineering (2007) *30/50 The Technological Implications of an Australian Population of 30 Million by 2050* Report of a study for the Scanlon Foundation by the Academy of Technological Sciences and Engineering

ATSE

30/50

OVERVIEW OF A STUDY FOR THE SCANLON FOUNDATION BY THE AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING (ATSE) 2007

ATSE

The Scanlon Foundation

The Scanlon Foundation believes that the future prosperity of Australia, underpinned by population growth, will depend on our ability to maintain social cohesion in a society with even more cultural diversity than we have successfully accommodated historically, whereby:

- Almost one in four current Australians were not born in Australia. Also half of Australians have had at least one parent born overseas;
- Australia's population is currently just over 21 million. Without migration, based on expected fertility and mortality rates, and at the current level of people emigrating, Australia's population will not reach 22 million;
- In the year to June 2005, Australia's net permanent migration level reached 105,000. If this level were to increase by 1.5 per cent a year over the next 45 years, Australia would reach a population of 30 million by the year 2050; and
- The international competition for migrants and for our own educated youth and skilled workers will continue to increase, making it more difficult to attract the migrants Australia needs.

On advice from the Australian Institute for Demographic Research of the Australian National University, the Scanlon Foundation adopted, as a working hypothesis, a future population for Australia of 30 million people by 2050. In shorthand this is referred to as "30/50".

The Foundation commissioned the Australian Academy of Technological Science and Engineering (ATSE) to advise whether there were any engineering, scientific or environmental barriers to reaching "30/50".

The Foundation, in addition to the ATSE work, has also commissioned:

- The Demography and Sociology Program at the Australian National University – to pursue work on Positive Immigration Strategies, in recognition of the likelihood of increased levels of immigration, and
- Monash University's Institute for the Study of Global Movements, in partnership with the Australian Multicultural Foundation – to examine issues of social cohesion inherent in "30/50", particularly how to continue the successful immigration accomplishments of the past five decades. The findings of this study, launched in mid-2006, will be presented in October 2007.

THE PROJECT CONTEXT

Looking ahead to 2050

The ATSE 30/50 Report results from a two-year investigation.

The Academy of Technological Sciences and Engineering (ATSE) was commissioned by the Scanlon Foundation in 2004 to advise whether there were any engineering, scientific or environmental barriers to reaching an Australian population of 30 million by 2050.

ATSE assembled a team of its Fellows with expertise in the critical areas to oversee the Study and to examine the specific engineering, scientific, environmental and planning issues associated with 30/50, including the potential impacts of climate change. The backgrounds of the authors are set out in the ATSE Report.

The ATSE 30/50 Report has been published as a book, titled
30/50 – THE TECHNOLOGICAL IMPLICATIONS OF AN AUSTRALIAN POPULATION OF 30 MILLION BY 2050
Inquiries for this publication should be directed to ATSE (paulaw@atse.org.au)

PRINCIPAL FINDINGS

No insurmountable barriers

In summary, the ATSE study concludes that there are no insurmountable engineering, scientific or environmental barriers to 30/50, assuming that thorough analysis and planning occur and that leadership is exercised, especially by governments.

Specifically, ATSE's Study findings are:

- there are no inherent physical, resource or technological barriers;
- Long-term planning is imperative to ensure timely and orderly provision of needed infrastructure; and
- Leadership from governments is essential in setting clear policy directions.

The current study reaches conclusions which are consistent with a 2000 ATSE Study[1] that found predictions of environmental disaster arising from population growth were ill-founded.

Australia has suffered significant environmental damage in the past and might again in the future if land, water and air are not better managed.

However, increases in many environmental impacts are not related to population size, per se, but arise from other activities more broadly related to how we plan for, manage and develop towns and cities, regions, catchments and natural resources.

There are, of course, population-driven impacts – depletion of arable land, poor waste disposal, water availability and water and air pollution, for example.

Mitigation measures, achieved through technological development, lifestyle changes, market instruments, policy and regulation responses and education, are needed to address these problems.

[1] see ATSE, Population Futures October 2000
http://www.atse.org.au/index.php?sectionid=200

ATSE

THE SCOPE OF THE ATSE STUDY

Systemic issues and specific topics

The ATSE Study showed that there are three systemic issues and five specific topics involved in meeting 30/50.

The systemic issues, common to all resource and infrastructure issues, are:

- The potential impacts of climate change;
- The investment required in infrastructure and the associated economic capacity, resulting from population growth and underlying economic trends; and
- The planning issues involved in integrating the complex and interlocking elements.

The ATSE Study also considered in detail five specific topics:

- water,
- energy,
- transport,
- waste management and
- social infrastructure.

The ATSE 30/50 Report, which addresses these issues and topics in detail, is summarised in this document. The conclusions are those of the individual authors.

THE SYSTEMIC ISSUES

Climate variability and change

The Study concludes that climate change should not be a barrier to 30/50.

This will be achieved in the context of a growing public understanding that, just as climate has influenced Australia's population location and development in the past, so too will climate change affect Australia in the period to 2050 and beyond. This will require adaptation responses and the consequent planning and provision of appropriate infrastructure, but should not be a barrier to 30/50.

The impact of climate on Australia's development has been a constant, indeed limiting, factor since European settlement more than 200 years ago. But future climate change, driven by global, anthropogenic increases in greenhouse gas emissions, will complicate planning in many sectors - energy, water and agriculture especially.

Projections of future climate are inherently uncertain. Continued monitoring and research are critical to reducing these uncertainties. Because Australia's climate is unique and because of Australia's relative isolation in the Southern Hemisphere, it is important that the nation contributes to, and benefits from, international climate change science.

To attain stabilisation of atmospheric concentrations of greenhouse gases (and therefore achieve a reduction in the rate of rise of global surface temperatures) emissions must first be reduced substantially. But, given the slow responses of natural systems in absorbing existing concentrations, the timescales for stabilisation are far longer than the 50-year time frame of the Study. As a consequence, the effects of the enhanced greenhouse effect will almost certainly be very apparent in 2050.

Varying impacts will be felt in different regional areas and there could be compounding effects. For instance, climate change will impact on water availability and therefore patterns of settlement and agriculture and, in turn, transport linkages and associated energy demands.

Among the sectors susceptible to climate change are:

- Human health and well being;
- Natural ecosystems;
- Energy;
- Water availability;
- Agriculture; and
- Natural disasters.

Migration from countries likely to be affected adversely by climate change, most of them in southern and south-east Asia and the Pacific Basin, could be an important factor in the migration mix and its impact on Australian society.

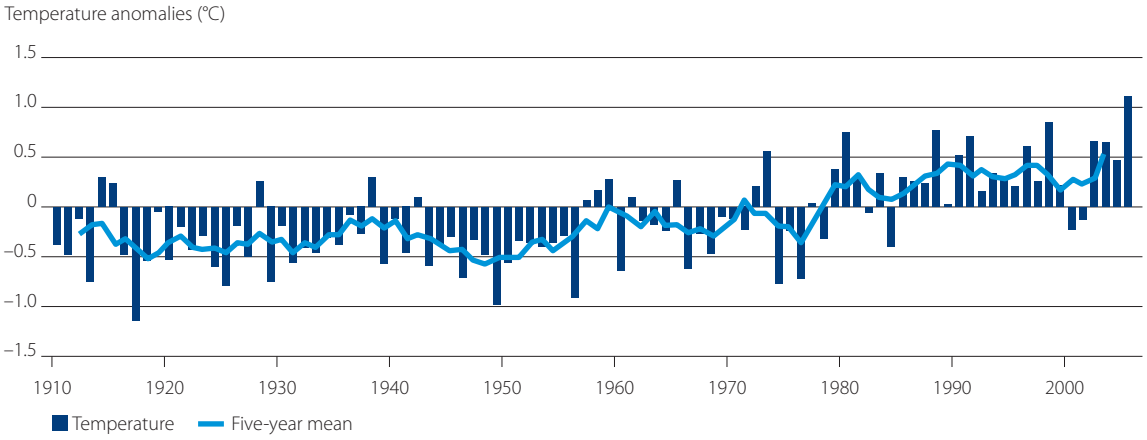
Policy responses to climate change involve both mitigation and adaptation. As direct signals of climate change are becoming apparent, there is now a significant focus on short- to medium-term adaptation.

In the key areas of susceptibility the Study identifies many planning and adaptation responses. These include prevention strategies for a potential increase in vector-borne diseases like malaria and dengue fever.

While there appears to be no trend in the rainfall deficit during wide-spread droughts, there has been an underlying upward trend in recent decades in temperatures in each successive major drought event. This is expected to lead to increased heat stress on humans, agriculture and ecosystems. These factors will need to be taken into account in planning for water storage, supply, usage and distribution, among other factors.

The history of Australian crop production suggests that agricultural industries can adapt to difficult climatic conditions but accelerated climate change will place additional stresses on agri-business. The future for wheat crops is mixed. There is evidence that the 30 to 50 per cent increase in wheat yields from 1952 to 1992 was partly due to increasing overnight minimum temperatures. But, as maximum temperatures rise and

Annual mean temperature anomalies for Australia - departures from 1961-1990 mean



Source: Bureau of Meteorology

water availability reduces, the positive impacts of frost reduction and of CO_2 fertilisation will be offset.

Some rural communities in the semi-arid regions of Australia could become marginally viable if rainfall deficiencies continue for long periods. Australia's competitive position in crop production may be affected by climate-driven changes in crop yields in other countries.

Taking into account the uncertainties associated with rainfall predictions, it is possible that the frequency of extreme rainfall events could increase in the Australian region, leading to more flooding events, and storm surges in coastal areas.

The impact of sea level changes needs to be an important planning criterion to ensure the safety of life and infrastructure along the coastline. Internal migration, potentially driven by water availability, could be a policy option, but one having social and cultural as well as economic implications.

In all of these areas it will be important to understand the impacts and to devise strategies to ensure that the affected sectors make adjustments. Given this, Australia will be able to develop and implement policies to manage climate variability and change (and capture any benefits), as population grows towards, and reaches, the 30/50 target.

Climate change and its consequences are a global phenomenon with global causes. While Australia's contribution to this global phenomenon is modest, Australia must pursue strategies to mitigate and manage the effects of climate change.

THE SYSTEMIC ISSUES

Infrastructure needs

With adequate planning and appropriate policy reform, there is little concern about Australia's ability to provide the necessary infrastructure to cope with 30/50, given the nation's resource endowment and capital availability.

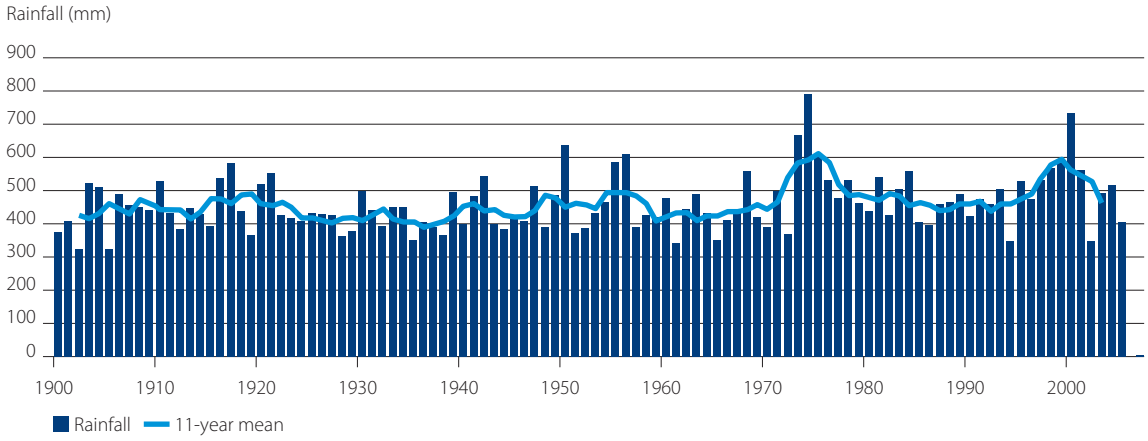
The Study concludes that demands on natural resources and physical infrastructure in 2050 will be a function of both population and economic trends.

Economic projections for the ATSE Study were derived from a general equilibrium computer model run by the Centre of Policy Studies at Monash University. This is widely regarded as the most comprehensive and credible model available.

The model does not assume any technological breakthroughs, industries are assumed to grow at similar rates as in the recent past and the overall rate of growth in the Australian economy is projected to be lower because of an ageing population. While economic modelling can be highly sensitive to these and other assumptions, long-term estimates for economic activity can be usefully derived for indicative planning.

On these projections, major investment in new infrastructure and brownfields expansions will be

Annual rainfall for Australia



Source: Bureau of Meteorology

required. Australians are likely to be more than twice as wealthy on average, suggesting that different classes of infrastructure will be particularly important, including goods and services with a high income elasticity of demand such as tourism, health care, private education and motor vehicles. An ageing population and an imbalance of growth between regions will also influence the pattern of infrastructure spending.

Technological change is notoriously difficult to forecast. But it is highly likely that it will have a major impact on infrastructure investment.

Should climate change lead to the Australian Government's participating in a global effort to stabilise atmospheric concentrations of greenhouse gases, macro and micro effects would follow. At the macro level policies to reduce emissions would almost certainly have a dampening impact on economic growth, thus lowering the required level of infrastructure investment. At the micro level, there would be impacts in certain sectors, particularly stationary energy. Nuclear power may be required for base-load electricity generation.

Despite the challenges described above and more specific ones associated with particular aspects of infrastructure needs (described later), the Study found that there were no infrastructure barriers to the 30/50 outcome, given adequate planning and appropriate policy formation.

THE SYSTEMIC ISSUES

The planning imperative

There are high levels of confidence in meeting the 30/50 target across all the engineering, technological and environmental areas examined.

But the Study highlights the critical need for leadership, planning and co-ordination among governments, agencies and other industry and community participants if the challenges are to be met successfully.

The complexities involved are significant, and do not belong to governments alone. While governments must ultimately set the policy frameworks, the Study concludes that robust public policy positions are needed by all stakeholders if environmental, economic and social shifts are to be accommodated in ways that solve problems rather than create major new constraints.

Citizens expect governments to guide the introduction, review and reform of the major national systems and institutions, so that they operate in predictable ways and serve their vital interests. But ministerial portfolios and public authorities are structured around particular segments or issues, rather than systems as a whole. A shift in emphasis is required towards actions that focus on the needs and management of whole ecological systems such as air sheds, land-based regions, river basins and remaining forest areas.

A major issue is to insure that investment in infrastructure is timely and efficient. Federal and State Governments must play an important role in this by ensuring that appropriate signals reach investors in a timely way, particularly in respect of those investments requiring large, upfront capital outlays and having an economic life of up to 50 years.

Despite growth in private and public partnerships, governments themselves will continue to be investors in infrastructure, requiring them to take on greater levels of debt. Decisions will increasingly need to be made on a national basis. A much greater role for the Council of Australian Governments is called for.

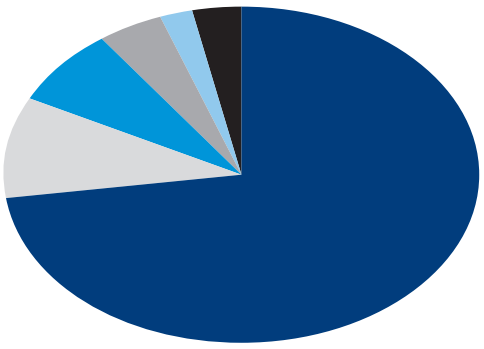
Even given the necessary emphasis on the critical need for government leadership, the Study recognises the difficult balancing act required by governments as they seek to promote a competitive economy, to reallocate scarce resources and to contain public expenditure while responding to increased demands for services, enhanced lifestyles and greater equity among all citizens.

Striking a sustainable balance requires business and citizens, as well as governments, to pay greater attention to the needs and management of whole systems, whether they are technological, societal or environmental.

All the partners involved in creating a cohesive, forward looking nation have an interest in success.

The Scanlon Foundation's Social Cohesion Research Program – and the ATSE Study as part of it – is designed to contribute to this process.

Water use in Australia



Agriculture 16,660 Gl (67%) Household 2,181 Gl (9%)
Electricity & gas 1,688 Gl (7%) Manufacturing 866 Gl (4%)
Mining 401 Gl (2%) Remaining industries 859 Gl (3%)

Source: Water Services Association of Australia, 2005

THE SPECIFIC TOPICS

Water

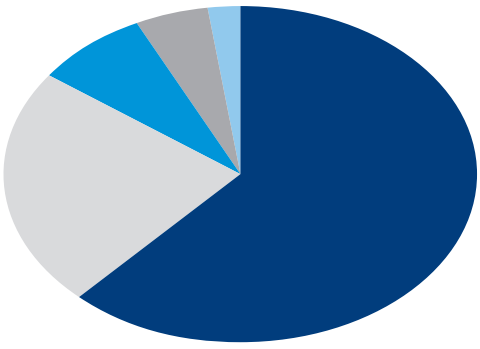
The Study finds that there does not appear to be any insurmountable engineering, health, scientific, economic or environmental barriers in meeting the water needs of 30/50.

The main focus of the Study is urban water, since population growth is likely to be concentrated in existing cities. Responding to the challenge of providing adequate urban water supplies to meet future population growth is in the context that urban water (household, manufacturing and other) currently accounts for some 16 per cent of total water use, whereas agricultural use accounts for some 67 per cent of total water use.

Australia is the driest continent and is already seeing a drastic reduction in run-off over the past 32 years in south west Australia, due to climate change, and in the Eastern States, due to drought (which may in turn be due to climate change). But demand management, with customer co-operation, is responding well to the challenge.

In aggregate terms, Australia has a plentiful supply of water (a view supported by the World Bank and studies conducted by the Barton Group).

Urban water consumption



Source: Water Services Association of Australia, 2005

However, much of the rainfall is in the under-populated north and it is currently uneconomical to transport water over thousands of kilometres from north to south. Many of the large water utilities have long-term planning in place (some for a 50-year period) and expect to meet future needs.

With the exception of Perth, Australia's major cities have added little new capacity since 1980 but this will need to change.

Current long-term planning will need to be strengthened by drawing on a diversity of sources, including those that are independent of rainfall and run-off – such as new surface and ground water schemes, agricultural sources, improved catchment management, increased demand management, recycling and sea water desalination.

Generally, all future sources will cost more and have high energy needs. At this stage, economic studies of desalination have demonstrated the economic fragility of schemes for north-south diversions of water (over thousands of kilometres) and some of the larger recycling proposals.

There are obvious risks in planning, given the 2050 horizon of the Study and climate change uncertainties. Planning will therefore need revisiting every five years. Technological research, policy formation (particularly to encourage water trading) and building customer education are necessary to differentiate between sound economic proposals and some populist proposals.

The ATSE study examines in detail several key areas of resource availability, infrastructure needs and planning issues associated with 30/50. These are water, energy, transport, waste disposal, elements of social infrastructure including educational, health, aged care and welfare facilities, plus communications infrastructure. The conclusions in each area are outlined separately.

THE SPECIFIC TOPICS

Energy

The Study concludes that Australia has adequate primary energy resources and reserves, apart from oil, to meet 30/50, and beyond.

However, there are particular problems with liquid fuels for transport that require resolution.

In the case of stationary power, climate change and the pressures both for short-term adaptation and effective long-term response are likely to see growing reliance on resources that are not carbon-based, including nuclear energy and, to a lesser extent, renewable energy.

The potential for improvement in end-user efficiency in industry, commerce and the domestic sector remains hugely significant. Present and emerging technologies offer dramatic reductions in energy consumption. However, the extraordinarily low cost of energy in developed economies, especially Australia, still constrains their more widespread acceptance.

Australia's energy research, development and demonstration capabilities are world class and strongly focused on long-term sustainability but they are an undervalued national resource.

Australia's 2050 energy resource mix will be different from the present. Hydro will reduce from eight per cent to about five per cent, natural gas can be expected to double from five to 10 per cent and perhaps 15 per cent, if competitive gas resources become available for base-load units, and renewable resources could reach 10 to 15 per cent, based on current economics, technology and government policies.

Time delays in achieving community acceptance of nuclear power generation and building nuclear generators would probably limit possible uptake of nuclear power to the five to 15 per cent range.

The balance of demand (notionally around two-thirds) will still need to be supplied by coal-integrated gasification combined cycle/sequestration units, capable of poly-generation to produce transport fuels or hydrogen. This is providing the relevant technologies prove to be economic.

Australians are accustomed to highly reliable but extraordinarily low-cost electricity, leading to a conflict between convenience and sustainability.

Power system investment could be significantly reduced, without loss of convenience or reliability but with enhanced sustainability, using effective peak-demand management. Investment in peaking capacity is unattractive at present retail prices, thus a reduction in peak demand is critical to limit poor infrastructure investment as well as conserve energy.

How this is to be done, short of draconian regulation or realistic price signals, is difficult to see.

Real-time charging initiatives, now being trialled, offer encouragement. Electricity prices will inevitably rise as resources become harder to recover and environmental sustainability costs are factored in, but it is believed that increased prices will not unduly affect or constrain the quality of life of a 30/50 population.

They could, however, inhibit new energy-intensive industries being established in Australia.

Perhaps the most likely pathway to meet the energy needs of 30/50 is a strategic mix of all fuel sources and technologies. The energy conservation and delivery mix will not, however, change quickly. It is therefore essential to develop long-term national strategic plans to move the energy mix in the desired direction, using government regulation where market forces alone would trend towards short-term optimisation.

This warrants a far more substantial policy and planning framework, based on national agreements, in part to overcome constitutional difficulties between State and Federal jurisdictions.

Australia's oil production is falling due to depletion of reserves, with the rate of discovery of new oil reserves not keeping up with production. Accordingly, Australia must adopt a number of strategies.

Industry must be encouraged to explore for

Australia's natural gas transmission pipelines

Source: Australian Gas Association

remaining Australian oil deposits (particularly in new frontier areas), diversify the sources of liquid fuel supply and/or attempt to mitigate demand. The development of alternative sources requires very long lead times, at least the order of a decade or more for hydrocarbon fuels and much longer for alternative sources of transportation power. This is where government can play a significant role.

In the case of petroleum-based transport fuels, it will be necessary to manage a transition to a larger, mixed economy in which liquid fuels are derived from a number of sources. This transition is not expected to present problems for fuel technologies. But the transition will be most difficult for aircraft fuels. Changes can also be expected in vehicle design. These include improved consumption and environmental efficiencies for internal combustion engines and the use of smaller cars and other vehicles that will have intrinsically lower fuel consumption requirements.

THE SPECIFIC TOPICS

Transport

The Study found that no significant insurmountable or uneconomic engineering, scientific or environmental barriers to providing adequate transport for 30/50.

But this assumes a change from the current transport planning and development systems which are often driven by political imperatives and operate on a short-term basis with little policy transparency – and more than a hint of the pork barrel.

Planning will have to be cast beyond the lifetimes of current governments and divorced from their traditional over-reactive approach.

These problems are compounded by another major obstacle – the differing priorities and overlapping responsibilities of local, State and Commonwealth authorities, particularly in land transport infrastructure. This implies a much greater role for the Council of Australian Governments in establishing agreed policies, priorities and modes of funding.

The scale of the challenges is indicated by the economic modelling undertaken by the Centre of Policy Studies at Monash University, and used elsewhere in this study. This shows that by 2050:

- The rail transport sector is expected to have grown by 3.6 times current levels;
- The road sector by 3.4 times;
- Air transport by 3.7 times; and
- Sea transport by 2.0 times. (This could be an underestimate given industrialisation of regional economies).

While funding levels need not differ greatly from current levels, they will need to be on-going and continuous. Current facilities are less than optimum and there is no leeway to accommodate investment shortfalls.

The largest transport problems will arise in urban areas, where the existing mass transport facilities are already struggling. In particular, arterial public transport routes will need to be upgraded and new road infrastructure built, requiring careful land use management controls.

Road vehicles will continue to play a major transport role but will be smaller, more fuel-efficient and travel at lower speeds. These changes will be partly driven by market forces but government regulation and incentives will be needed to ensure safety and alignment with national policy priorities. It is probable that "fit for purpose" rental fleets of vehicles will be used for personal travel.

Buses will be the dominant transport mode in outer urban fringes, improved through the use of better telecommunications and on-board electronics. Similarly, systems will be needed to electronically lock personal vehicles together into virtual "buses" when operating on high-demand routes.

Railway systems will have to be rejuvenated and firmly linked to other transport modes to provide an integrated transport system, supported by advanced information and communications technologies.

Australia's relatively large urban areas, with mixtures of housing and industry, are inefficient for freight distribution.

Major capital expenditure and alternative technologies will be needed to provide good regional freight links to urban distribution centres. In cities, greater use of tunnels, carrying autonomous delivery vehicles, might contribute to solutions.

For regional areas there is an even greater need for integrated planning of road transport, leading to an effective grid of freeways and tollways. Attention will inevitably return to rapid transit trains to connect city centres, at speeds approaching that of aircraft.

The planning of Australia's transport needs will require an international perspective. Global trade and alliances will be key components in successful policy making. Under-investment in the nation's international transport systems would significantly diminish our trading ability.

THE SPECIFIC TOPICS

Waste disposal

The Study concludes that Australia has the space and resources necessary for waste management and therefore this should be no barrier to 30/50.

With acceleration of waste management programmes (for example urban waste reduction, recovery and recycling) there is an opportunity for Australia to produce less waste in the future than it does now.

Australians currently generate more waste per capita than in most other developed countries, partially in response to its low density of population and abundant space for landfill disposal.

Research for the Study shows the collection, sorting and recycling of materials is not driven by the economies of the recovered materials.

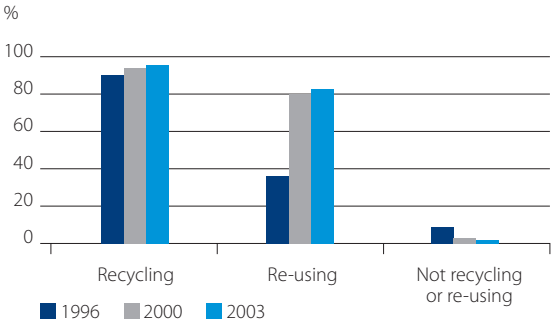
The combined costs for doing so in respect of most glass, plastic, paper and metals is seldom less than the selling price of the recovered materials.

Yet recovery and recycling is supported at all levels of society and it is recognised that recycling can reduce the demand for landfill, lessen the environmental impacts and make some financial contribution.

All States and Territories have ambitious goals for waste minimisation but available information indicates that these have not been met in full.

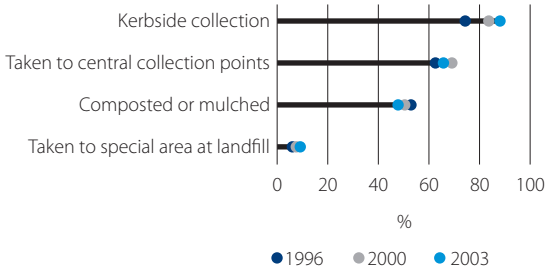
Management of wastes is an important health and environmental issue. Some wastes are toxic and can harm living organisms. Their safe disposal is of particular importance.

Waste recycling/re-use by households



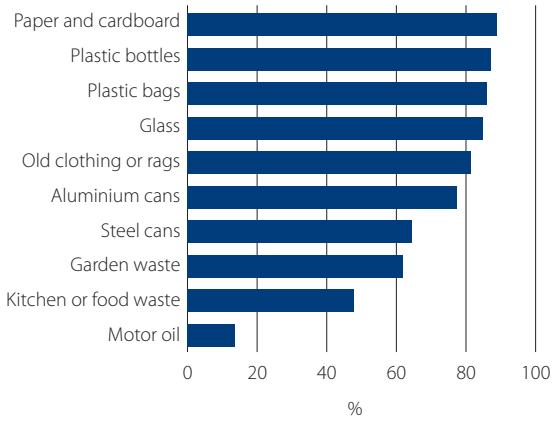
Source: *Environmental issues: People's views and practices,* 2004

Methods of recycling by households



Source: *Environmental issues: People's views and practices,* 2004

Items recycled/re-used by households, March 2003



Source: *Environmental issues: People's views and practices,* 2004

THE SPECIFIC TOPICS

Social infrastructure

No barriers are seen to 30/50, providing a substantial increase in infrastructure spending occurs in various areas.

Several social infrastructure issues were considered (as part of an integrated assessment of infrastructure). These include educational, health, aged care and welfare facilities and communications.

An impediment to infrastructure development is the current overlapping of governmental and other agency responsibilities, leading to under-investment, or inefficient investment. Reforms are needed.

Using a "high" alternative, by 2050 life expectancy for men will be 92.2 years and for women 95 years. Low rates of savings, increased used of pharmaceuticals and increased life expectancy are expected to increase demand for public housing, health facilities and community health services.

While migration patterns will have an influence, it is expected that there will be fewer children as a percentage of the total population. Some educational assets may therefore be converted to other uses. In particular, growth in the economy, particularly productivity growth, will require workers to upgrade their skills continually.

This implies rates of demand for education services growing at rates faster than employment growth.

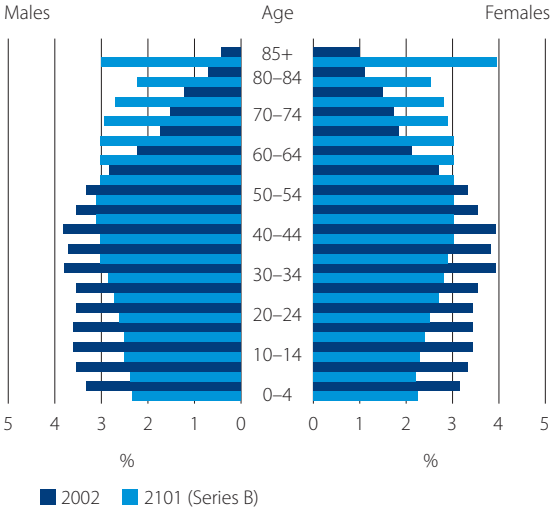
Apart from the demographic effects, increased wealth for Australians will create a significant demand led expansion in the use of medical services.

A constant recurring theme through the Study is the need for vastly improved communications infrastructure – telephone lines, broadband capabilities, cable infrastructure and wireless connectivity. The economic modelling undertaken for this Study predicts roughly a 500 per cent increase in the need for communications services by 2050.

Despite the high take up of internet access (84 per cent), penetration of high speed broadband is comparatively low. Australia's projected GDP growth will be driven by increased use of communications and this, in turn, will fuel greater demand for more services. Inadequate communications facilities will place business at a serious competitive disadvantage.

Much of the needed infrastructure will be funded by the private sector but there are clear roles for government to act strategically to ensure adequate investment in communications. Strategies include demand aggregation and other targeted infrastructure funding schemes.

Population projections, Australia, 2002 and 2101



Source: Australian Bureau of Statistics, 2003

ATSE – in brief

ATSE is an independent, non-government organisation, promoting the development and adoption of existing and new technologies that will improve and sustain our society and economy.

ATSE consists of more than 750 eminent Australian Fellows and was founded in 1976 to recognise and promote the outstanding achievement of Australian scientists, engineers and technologists.

ATSE provides a national forum for discussion and debate of critical issues about Australia's future, especially the impact of science, engineering and technology on quality of life.

ATSE links Australia with leading international bodies and worldwide expertise in the technological sciences and engineering.

ATSE fosters excellence in science, engineering and technology research and the critical education systems that underpin Australia's capacity in these areas.

ATSE tackles many of the most difficult issues governing our future, by offering fresh ideas, practical solutions and sound policy advice – and putting them on the public record.

ATSE

30/50 - The Technological Implications of an Australian Population of 30 Million by 2050
Overview of a Study for the Scanlon Foundation

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Appendix 2

Ageing-in-place: Living well with enabling technologies (2011) Short Guide to the report by the Australian Academy of Technological Sciences and Engineering[1]

[1] Australian Academy of Technological Sciences and Engineering (2010) *Smart Technology for Healthy Longevity*

4th March 2011

AGEING-IN-PLACE: LIVING WELL WITH ENABLING TECHNOLOGIES

A SHORT GUIDE TO THE REPORT

SMART TECHNOLOGY FOR HEALTHY LONGEVITY

Prepared by the Australian Academy of Technological Sciences and Engineering (ATSE)

FEBRUARY 2011

AGEING-IN-PLACE: LIVING WELL WITH ENABLING TECHNOLOGIES

A national policy is required for the research, demonstration, commercialisation and wide-scale deployment of smart technology for ageing-in-place to ensure: a healthy, safe, secure and fulfilling future for the increasing aged population in Australia by enabling them to remain at home longer, by easing the strain on the national healthcare system and providing cost effective solutions to meet the needs of the growing number of elderly Australians.

Executive summary

The mounting challenges of population growth and demographic ageing will place a considerable strain on Australia's national healthcare system, leading to increased healthcare costs and a risk of lowering the standards, not only for older Australians, but all Australians. To address these challenges, Australia will need an increased national focus on the R&D, commercialisation and deployment of smart technology to enable the elderly to remain in their homes longer and provide cost-effective solutions to meet the needs of an ageing population. New health funding models to support the wide-scale deployment of these technologies will be required to achieve the potential savings and benefits.

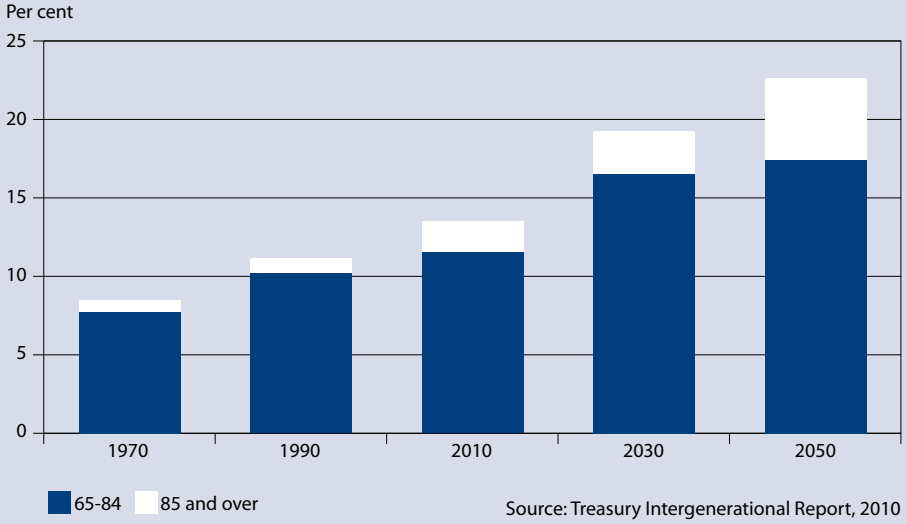
The Academy of Technological Sciences and Engineering's (ATSE) landmark report, ***Smart Technology for Healthy Longevity***, reviews the state of aged care technology in Australia and in Europe, looking ahead to the future of ageing-in-place, where elderly individuals are empowered to remain in their own homes and, crucially, explores how technology can be utilised to realise this vision. This document is a short-guide document is based on the ATSE report, which can be downloaded at www.atse.org.au/news/featured-articles/155-smart-tech-for-health-longevity.

Population pressures: the challenge of an ageing society in Australia

Australia's population is projected to grow to 36 million by 2050, comprising 7.8 million people aged over 65 and 1.8 million over 85. Population growth poses immense challenges for energy, transport, education and water, as current urban habitats are likely to be enlisted to accommodate the largest increases of this growth. Furthermore, demographic ageing[1] will lead to significantly increased healthcare costs which will be further accentuated by a reduction in the healthcare workforce. Technology offers cost-effective solutions to enable ageing-in-place (whereby people can remain at home safely and securely, for longer) and provide medical support and treatment; technology can be deployed to relieve the pressure on the service provider hubs of the national healthcare system, offering the potential for substantial saving in both residential aged care and in overall healthcare for the elderly.

Demographic ageing is taking place in all developed countries and an increasing number of developing countries, due to longer life spans and declining birth rates. Although Australia's continued high immigration rate has buffered the process, slowing the rate below that in Europe or Asia where demographic ageing is happening substantially faster; demographic ageing in Australia is inducing a population change (Figure 1). The number of people of working age (20 to 64) relative to older people, currently stands at 5:1. **By 2050, population ageing will have driven this 'demographic support ratio' down to 2.7:1**, indicative of a smaller proportion of people of working age to support retirees. This will eventuate in a shortage of healthcare professionals to attend to the increased number of older persons and is symptomatic of a significant economic challenge that will demand improved productivity to be overcome.

Figure 1 Projection of the proportion of the Australian population aged 65+



Source: Treasury Intergenerational Report, 2010

Older people have higher healthcare demands, as they proportionally incur higher levels of chronic illness, disability and degenerative diseases. They need increased resources to be invested in the development of new drugs and medical procedures related to age, inducing higher costs to governments. The Australian Government, in the *2010 Intergenerational Report*[2], **forecast a sevenfold increase in health spending on people aged over 65**. Government urgently needs to consider how technology, in a range of areas, can be adapted, developed and deployed to reduce costs and improve the quality of life for the elderly. Technology not only can provide solutions to overcome barriers of safety and security, diagnosis and treatment, but assistive technologies offer significant potential to reduce costs.

A larger number of older people may have a very positive impact on society, especially if healthy years can be extended. In addition to new models of healthcare and training to accommodate the increased demand for health services by older people, a radical change of mindset is required to overcome the current stereotype of older people as unable or unwilling to deal with new technology.

Ageing-in-place: responding to the challenge through technology

There is a suite of emerging innovative technologies that offer the prospect of enhanced security, safety, diagnosis, treatment and physical assistance to improve the quality of life for older people and to empower them to remain safely at home. The numerous smart technologies currently available support ageing-in-place in a number of ways, for example, by **providing early alerts to changing**

health patterns or by minimising falls and other accidents in the home. This also enables substantial financial savings in residential aged care, medical treatment and through reduced admissions to hospitals.

To enable successful ageing-in-place, technology must provide solutions to issues such as **personal health monitoring, telehealth, shopping, cognitive training and education. Information communication technology** (ICT), particularly wireless communication, can be used to address these challenges in the context of housing for older people and, crucially, is a key enabler of social communication. These smart enabling technologies can be deployed and implemented into existing homes; however, future homes will need to be designed especially in order to incorporate the required systems and to provide for the life-long needs of the occupants. This will demand modification to the Building Code of Australia.

Although there is already a substantial investment in R&D capacity in this area in Australia, particularly in the field of **telehealth** (Figure 2), more needs to be done to strengthen and coordinate this activity and to ensure that public and private aged care authorities and organisations can effectively utilise the outcomes. Many technological solutions already exist but are not being utilised to their full potential, for example, individual devices are not compatible for linking to a common control system. Other barriers include poor design for ease of use and maintenance, a lack of consultation with users about their needs, high cost and a lack of policy on financing. To overcome these barriers, there is a need for: **national and international protocols for the connection of wireless devices; improved awareness in industry and business of the potential markets for technology for the aged population; and national policies for funding elderly-friendly homes.**

There are **numerous opportunities for Australian business and industry to capitalise on the projected expanded markets**, both in Australia and abroad, which will be opened up with the increased development and application of smart technologies for coping with ageing and the development of a national broadband system (NBN) that will facilitate the mobilisation of e-health and enable greater integration of the elderly into society by assisting enhanced social communication.

Technological opportunities in aged care for Australia

Delivering solutions to the complexities and challenges inherent in the deployment of technology to the aged will demand a broad combination of technologies, specifically: nanotechnology, biotechnology, ICT and cognitive science. In accordance with the objectives of the Australian Government's National Enabling Technologies Strategy (which marks the convergence of the aforementioned technologies to focus on areas of social, economic and technical importance and emphasises the importance of potential for development by business and industry) several technological opportunities for Australia have been identified, in three categories (see right).

Gerontechnology[3]: lessons from overseas and opportunities for Australia

The concept of applying these smart enabling technologies to the medical aspects of ageing (gerontology) to assist in daily living is termed 'gerontechnology'. Worldwide, the concept of gerontechnology is well established in national agendas as illustrated by **significant activity in the development of technologies for the aged population** in the US, Japan and in particular in Europe, where there are well-organised and well-funded national and multi-national programs including elderly-friendly housing. This is particularly crucial for accommodating the needs of dementia sufferers, which is a key area for action in Australia given the increasing frequency of dementia and the growing shortage of carers. Large-scale **developments of elderly-friendly housing in Australia linked to studies** of aged people in these environments are required to fully understand the potential of these technologies to improve quality of life and deliver financial savings in Australia.

It is imperative that the concept of gerontechnology is established in Australia, in education, research, industry and business. It is important that it is applied as a means to coordinate R&D activity in this area. Despite having numerous formal centres of activity on health and ageing in a number of universities across the country, Australia, unlike Europe and North America, does not have any centres for gerontechnology and there is a lack of overall coordination on a national scale. Given that research on gerontechnology in Australia is dispersed through a number of different areas, expenditure is difficult to estimate. **An audit of activity and funding on gerontechnology is urgently required.**

Opportunities for Australia

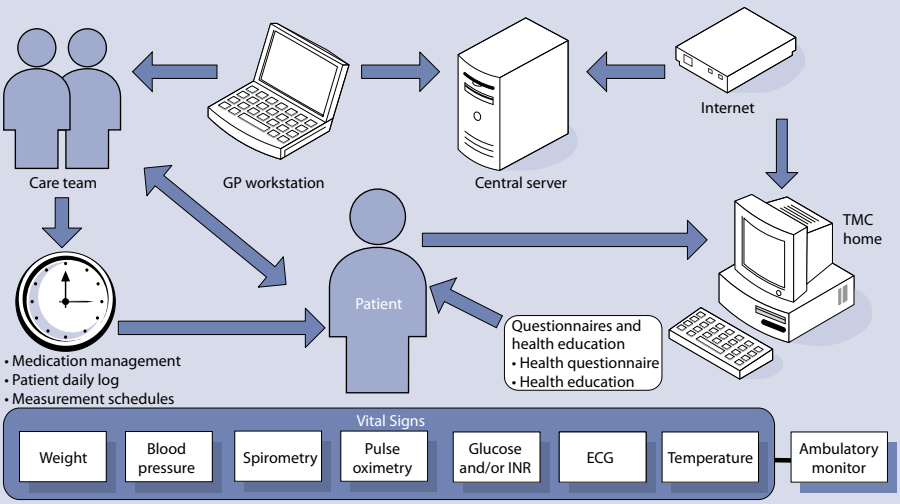
1. Security and safety – elderly-friendly homes, prevention of falls, communication and social interaction.
2. Diagnosis and treatment – telehealth, coping with degenerative diseases, nanomedicine.
3. Assistive technologies – biorobotics, brain/machine interaction, mobility systems.

Funding models

Current funding models focus on institutional care as opposed to keeping individuals in their own homes. The Productivity Commission (2011) in *Caring for Older Australians*[4] recently identified the need for new funding models to accommodate the increased demands on the healthcare system as a result of demographic ageing and for elderly people to remain and receive care at home.

This echoes the findings of the ATSE report that **there is clear need for a new funding model to facilitate the wide-scale deployment of technologies to enable ageing-in-place**.

Figure 2 Schematic of a telehealth system



Source: Professor Nigel Lovell TeleMedCare Pty Ltd

Social and ethical issues

Although there are clearly a multitude of benefits that may arise from the use of smart technologies in the home environment, there are also threats and vulnerabilities which must be addressed; particular issues surround privacy, autonomy, informed consent, identity and dignity.

Conclusion

To realise the potential of smart enabling technologies to achieve reduced healthcare costs and enable older Australians to enjoy a high quality of life and to remain safely in their homes for longer will demand national coordination to make optimum use of the available resources and sustained commitment to R&D support. There is a need for universities to synthesise a range of skills in Centres of Excellence in Gerontechnology to provide research and training in the application of smart technologies for healthy longevity. Meanwhile, awareness should be raised amongst healthcare authorities, the insurance industry and the public as to the potential of smart technologies to assist in providing healthy, secure and happy futures for the aged population. Furthermore, Australian business and industry should be alerted to opportunities for commercialisation of outputs from gerontechnology R&D. The ATSE study identified three key gerontechnology opportunity areas for Australia: security and safety; diagnosis and treatment; assistive technologies. The report makes nine recommendations for the development and deployment of these technologies to improve quality of life for elderly Australians by enabling ageing-in-place.

Summary of recommendations for using technologies to enable ageing-in-place in Australia

1 Support gerontechnology from research to deployment

The Australian Government **Departments of Health and Ageing (DOHA)** and **Industry, Innovation, Science and Research (DIISR)** should develop a National Research and Development Agenda on Technology and Ageing to ensure national coordination of existing programs relevant to gerontechnology; identifying priority areas and ensuring sufficient funding for their research, demonstration, commercialisation and wide-scale deployment. This would complement the National Strategy for an Ageing Australia and the National Enabling Technologies Strategy and be in line with the Australian National Research Priorities.

Where clusters of expertise exist, universities and research institutes should be encouraged through joint **Australian Research Council (ARC)/National Health and Medical Research Council (NHMRC)** support to set up Centres of Excellence in Gerontechnology.

The **Department of Health and Ageing** should be tasked to develop a new funding model to support ageing-in-place and to capture the economic benefits.

2 Understand the potential economic and societal benefits of ageing-in-place

The **Productivity Commission** should be tasked to carry out a study of the potential savings arising from maintaining seniors safely, securely and happily in their own homes by using technologies that are available or under development in Australia. The **Productivity Commission** should also be tasked to advise on a new funding model for wide-scale deployment of technology for the ageing population.

Medicare and the health insurance industry need to assess the potential of new technologies to reduce serious accidents and other events which can lead to hospitalisation of elderly people, and to implement mechanisms that encourage the application of new technologies.

3 Deploy gerontechnology solutions to successfully deliver the benefits of ageing-in-place

The Australian Government **Department of Education, Employment and Workplace Relations (DEEWR)** should establish a Taskforce drawn from relevant Skills Councils to identify the training and accreditation needs of a future gerontechnology workforce operating in the home environment. This should be seen as a component of the National Health Workforce Strategic Framework.

The **Privacy Commissioner** should be tasked to examine the issue of privacy in the application of technologies to the aged population.

4 Recognise the concept of ageing-in-place to enable independent living for the aged population

Ageing-in-place should be an essential component of the National Strategy for an Ageing Australia. **DIISR** should actively seek to ensure Australian participation in international programs and projects on gerontechnology to amplify our limited resources and gain access to new findings.

"Older Australians generally want to remain independent and in control of how and where they live their lives."

– Mike Woods, Deputy Chairman, Productivity Commission (2011)[5]

Further Information

The ATSE report *Smart Technology for Healthy Longevity*, authored by Professor Greg Tegart AM FTSE, was launched by Professor Margaret Shiel FTSE, Chief Executive Officer of the Australian Research Council, in July 2010 in Melbourne.

The Academy of Technological Sciences and Engineering (ATSE) is an independent, not-for-profit organisation. Our Fellowship, composed of more than 800 outstanding scientists, technologists and engineers, drives our mission: to foster excellence in technological sciences and engineering to enhance Australia's competitiveness, economic and social wellbeing and environmental sustainability. As an independent, science and technology evidence-based policy think-tank, ATSE provides robust, independent policy advice to government, industry and the community and a forum for debate and policy formulation on major national issues. Further information can be found at www.atse.org.au/about-us.

The full report and accompanying presentations can be downloaded from the ATSE website (at **www.atse.org.au/news/featured-articles/155-smart-tech-for-health-longevity**). Limited hard copies are available from Harriet Harden-Davies, 03 9864 0926, harriet.hardendavies@atse.org.au

Notes

1. Demographic ageing is the process by which an increased population triggers a change in the population balance between old and young people.
2. Australian Government (2010) *Intergenerational Report*
3. Gerontechnology is the linking of medical aspects of ageing to advanced technologies.
4. Productivity Commission (2011) *Caring for older Australians*
5. 'Major overhaul proposed for Aged Care', Media Release, www.pc.gov.au/projects/inquiry/aged-care/draft/media-release

Australian Academy of Technological Sciences and Engineering (ATSE)

Appendix 3

Low-Carbon Energy (2010)
Short guide to the report by the Australian Academy of Technological Sciences and Engineering[1]

[1] Australian Academy of Technological Sciences and Engineering (2010) *Low Carbon Energy: Evaluation of New Energy Technology Choices for Electric Power Generation in Australia*

4th March 2011

ATSE

LOW-CARBON ENERGY

SHORT GUIDE TO THE REPORT

LOW-CARBON ENERGY
EVALUATION OF NEW ENERGY TECHNOLOGY CHOICES FOR ELECTRIC POWER GENERATION IN AUSTRALIA

Prepared by the Australian Academy of Technological Sciences and Engineering (ATSE)

NOVEMBER 2010

TAKEOUT MESSAGE

The one undeniable fact that has emerged in recent work in this area – and highlighted again in the *Low Carbon Energy Report* by the Australian Academy of Technological Sciences and Engineering (ATSE) – is that the financial viability of low-carbon electricity generating technologies to offset reducing greenhouse gas emission targets will require electricity prices to rise substantially over time and imply a price on carbon that escalates as targets are elevated.

This reality has been subsequently underscored by modelling by the Australian Energy Market Operator (AEMO) which emphasised the need for carbon pricing clarity to provide an environment conducive to new energy generation investment.

It is apparent that to find the right low-carbon technologies is going to require some very skilled decision-making – and that nothing can replace coal-fired base-load power in the current pricing regime.

Key points

Australia faces a long period of heavy investment in low-carbon energy technologies, especially for generating electricity. This is required to meet the increasing demand for electricity and respond to climate change by reducing emissions through application of an expected price on carbon. Given this environment, there is a need to facilitate improved investment decision-making associated with these technologies for both the energy sector and public policy makers.

The ATSE Report explores the usefulness of a financial tool, Net Present Option Valuation (NPOV), in supporting investment decision-making. NPOV complements the more traditional calculation of future Levelised Costs of Electricity (LCOE). It is more amenable to incorporating uncertainties and statistical variations in future technology costs and carbon prices and to understanding their impacts.

The financial analyses in this work have the benefit of access to the most recent set of Australian cost data for power-generation technologies, including learning curves for future improvements and cost reductions, rising electricity price projections and potential carbon prices. Authoritative as they are, such data are inherently uncertain and will continue to change over time.

Technology-specific financial data can provide only a starting point for investment decisions. The newer technologies still face many technical hurdles. Design of integrated power networks will need, at the very least, progress in these technologies and in understanding the costs of managing and delivering secure power from remote sites and intermittent energy sources like solar and wind.

The breakthrough value of this study is that the future rankings of attractiveness of alternative power generation technologies that emerge from LCOE and NPOV modelling are similar, but with NPOV techniques explored in the Report providing additional insights for future decision-making.

NPOV is a measure of the current value of a particular future technology investment. When divided by the present value of the capital expenditure, PV(X), the result is normalised. A positive NPOV/PV(X) is worthwhile and the higher the value the better.

Energy Minister Martin Ferguson (right) launches the ATSE report.

Synopsis

The main findings for the set of technologies studied here are:

- Technology rankings that emerge from models for LCOE and NPOV are similar, with NPOV providing additional insights.
- Only wind, CCGT and favourably located geothermal have significant option value in 2020.
- By 2030, option values increase, with gas-fired technologies, including gas-firing with carbon capture, having the highest values. By 2030 option values for wind and nuclear are moderately high, while for solar and coal-fired technologies, including those **with** carbon capture, they are low.
- By 2040, all of the technologies considered, except coal firing **without** carbon capture, have significant option values. The highest option values are associated with combined cycle gas plus carbon capture, wind, low-cost geothermal, solar thermal with central receiver, and nuclear.
- Future gas price represents a high financial risk factor for generators investing in gas technologies for base load generation.
- Cost of capital for the investor has significant influence on option value, which is also sensitive to capital cost of installed capacity, thermal efficiency, and operating costs of the technologies.
- For solar thermal technologies, incorporation of energy storage improves option value slightly.
- Overall, the results suggest that future electricity generating portfolios in several decades could be drawn from a wide choice of individual technologies, provided that the anticipated level of technology learning occurs and the price of electricity and carbon rises at the rates projected by the Australian Treasury and the Garnaut Report.
- The present option value of the portfolio of new technology options for investment in the period 2030 to 2040 is some $10 billion. This provides an indication of the investment that can be made now in support of these electricity generating technologies, such as infrastructure development together with R&D and technology development to accelerate learning. Further work is required to confirm the validity of this estimate.

Net present option valuation

NPOV is the present value of a choice to make a future business or investment decision. It is particularly suited to evaluating an investment under conditions of uncertainty and volatility – in future prices, product demand and/or asset value. The method captures the value of any progressive resolution of future uncertainties as a project progresses and of the managerial flexibility to wait, abandon, or expand on an investment opportunity. It appears to have promise as a tool for assessing the value of future electricity generating technologies where costs and prices are explicitly uncertain – costs, because the technology is not yet fully developed or demonstrated and future fuel prices are subject to expected but unknown rises; and electricity price, because of unknown future policy responses to climate change, such as a price on carbon dioxide (CO_2) emissions.

Technologies using tide, wave, biomass and other energy sources would also be amenable to the analyses used here but were outside the scope of the work because of lack of suitable (moderated) financial data. Similarly, this kind of analysis could also be conducted for energy efficiency projects if suitable data were available.

Net present option values, as shown in the chart (below), were found to correlate with levelised costs via a non-linear relationship. While they follow similar trends, option value offers a more sensitive indicator of the future financial viability of a technology.

The rate of change of CO_2 price over time adopted in the Treasury/Garnaut models has a significant effect on NPOVs. The CO_2 price trajectory must be close to that predicted by these models for the new technologies to have reasonable net present option values and positive net present values by 2030–40.

Gas price and its future trajectory are important variables for NPOVs of gas-fired technologies. Within the range of price escalators in future scenarios as published by the Australian energy regulator, gas-fired technologies can have high or low NPOVs. Future gas price therefore represents a high financial risk factor for generators investing in gas technologies for base-load generation.

The cost of capital for the generating company has a significant influence on NPOV, which is also sensitive to the capital cost of installed capacity, thermal efficiency, and operating costs of the technologies. For solar thermal technologies, incorporation of some energy storage slightly improves net present option value.

Overall, the results of this study show that an options value model can effectively discriminate between the financial viabilities of new power generating technologies and provide guidance for investment aimed at capturing the value of these technologies. It is recommended that the model be applied further in order to assist choices between technologies, their supporting infrastructure and their deployment options.

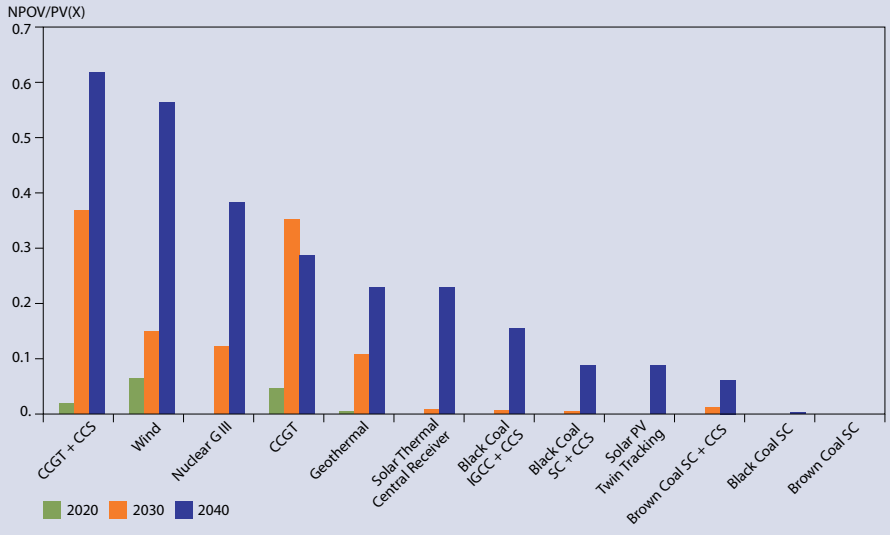
Future Activities

Focused research, development and demonstration (RD&D) programs are required to accelerate improvement of the key technology parameters in certain new power generating technologies, in order to facilitate their commercial deployment and their application in the portfolio of technologies that Australia will need for a secure electricity supply and to achieve reductions in the level of greenhouse gases. The financial opportunities and risks associated with these programs are an important part of the development process.

To facilitate the commercial deployment of these technologies, ATSE suggests that:

1. The NPOV model, shown in the Report to discriminate effectively between the investment attractiveness of new power generating technologies, should be applied further to explore its applicability. This will include its contribution to the development of an energy policy, such as to assist in identifying the relative benefits of different technologies and to establish how much investment should go to:
   a) RD&D in the near term, before deployment; or
   b) other preparatory expenditure prior to a commitment being made in future to large scale commercial deployment.
2. The ATSE NPOV model should be applied further to technologies that have not been considered here, including:
   a) Integrated drying and gasification of brown coal, biomass combustion for power generation, ocean- and tidal-derived power technologies and technologies involving distributed networks such as solid oxide fuel cells;
   b) Transmission costs for networked new technologies (such as remote wind, solar power and geothermal facilities);
   c) Projects aimed at energy efficiency improvement, especially at large scale in industry; and
   d) Analysis of specific choices, such as the size of initial CO_2 mitigation infrastructure developments in power generation hubs.
3. Further extension of ATSE modelling should be carried out to enable its application to identify a portfolio of new technologies in real power systems and networks. By 2040 there is expected to be available a wide range of technologies having high NPOV, including wind, nuclear, solar thermal with central receiver, and geothermal. Such analysis should be continued and tracked over time as new input data for developing technologies become available.
4. The applicability of the ATSE model to a specific site using a specific technology should be explored.
5. Further work should be undertaken to confirm the assumptions regarding matters such as: the volatility of the input variables; the relationship assumed herein between the price of CO_2 and electricity price; the change of these two prices with time; and the future natural gas price.

Normalised net present option values (NPOV/PV(X)) as a function of technology for 2020, 2030 and 2040



6 Software should be developed to provide a user-friendly interface to the models so that they can readily be applied to specific projects and problems by both public sector and commercial users. Concurrently, the analytical tools intended for such general usage should be regularly updated with new input data concerning the subject technologies, as these become available.

Findings

The key findings of the report and the associated recommendations are listed below.

FINDING 1

The LCOE and NPOV results demonstrate that for future low-carbon technologies to be financially viable there will need to be a price on carbon and that electricity prices will need to rise substantially over time.

Recommendation

That consideration be given to placing a price on carbon, broadly consistent with the trajectory used in this study, if future low-carbon technologies are to become financially viable.

FINDING 2

The LCOE and NPOV results demonstrate that a portfolio of low-carbon technologies can economically be deployed over time.

Recommendation

That a suite of low-carbon technologies be developed for possible future commercial deployment.

FINDING 3

NPOV provides additional insights into "rankings" of alternate power generation technologies.

Recommendation

That further work be conducted to demonstrate the validity of the Net Present Option Value model developed in this study and to extend its application to site and technology specific studies.

FINDING 4

NPOV indicates RD&D investment of some $10 billion in the period 2030 to 2040 to support of these alternate technologies but notes that further work is required to validate this estimate.

Recommendation

That further work be conducted to demonstrate the validity of the Net Present Option Value model developed in this study to estimate the investment that can be justified in RD&D for the technologies investigated and to extend the investigation to other technologies not considered in this study.

Reaction

Mr Martin Ferguson
Minister for Resources and Energy, Australian Government

"This report comes at an important time for our energy sector and I welcome this contribution to the current debate. ATSE's report brings an investor's perspective to the analysis of technology choices we will face out to 2040. The report helps us understand the implications of policy and technology uncertainty on investor choices and the associated risks.

"ATSE's report calls for focused research, development and demonstration programs to accelerate the commercial deployment of new power generating technologies. Only a range of technologies will ensure our future energy security, and help us reduce greenhouse gas emissions."

Dr Bruce Godfrey
Chair, Research Advisory Committee, Australian Solar Institute

"The options analysis allows one to test whether, for example, how changes in CAPEX, OPEX, efficiency, capacity factor, etc affect – and by how much – the option value of a particular technology. From that analysis a view of the priority for innovation investment can be derived which would say 'put your buck here because it delivers the greatest potential return' for that technology. An example might be lowering the capital investment of a concentrating solar thermal mirror field compared to, say, increasing the capacity factor (through incorporation of thermal storage) or increasing the efficiency of conversion (through higher temperature operation) of the complete solar thermal power plant.

"Of course, many may say 'well, those choices were obvious anyway' – but there's usually precious little analysis available anywhere to innovation investment organisations to provide a real foundation to their investment decisions."

Mr Keith Orchison
Energy industry commentator
Former Managing Director, Electricity Supply Association of Australia

"As Energy Minister Martin Ferguson said in launching the ATSE report, this is core business in the ongoing effort to introduce low-carbon energy technologies 'in a manner that does not impose an unreasonable burden on the community or industry.'

"What the ATSE report boils down to — so far as short/medium-term policymaking is concerned — seems to be this: (1) We are going to need a lot of CCGT installed before and beyond 2020, so the policy to attract this investment is important; (2) in the context of the carbon target, making sure the necessary wind power is built is important and the RET market is still a bit of a mess; (3) pouring taxpayers' and consumers' funds in to forcing solar power in to today's market is a mug's game and the current mish-mash of approaches is not helping one bit; (4) carbon capture and storage is nowhere near being commercially available and, given its importance to the Australian scene, needs more effort; and (5) when it comes to use of nuclear power, the politicians may run, but they can't hide: in our decarbonising environment, given the equally important goal of "not imposing an unreasonable burden on the community and industry," the nuclear option needs urgent attention if it is to be part of the mix beyond 2020."

The ATSE Report – ***LOW-CARBON ENERGY Evaluation of New Energy Technology Choices for Electric Power Generation in Australia*** – was launched by Energy Minister Martin Ferguson in Melbourne in December 2010. It was followed by a technical seminar.

The Report, the Minister's speech and the presentations at the technical seminar are available on the ATSE website at www.atse.org.au/events/55-public-lectures/226-official-launch-of-new-study-report-01-dec-2010

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